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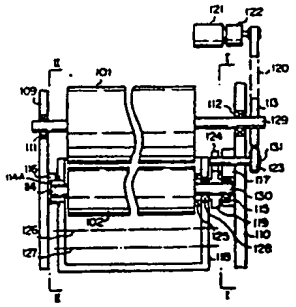
(54) Electrophotographic printing apparatus.

(57) A printing apparatus has a removable developing unit including a casing (118), for holding developer powder, and a developing roller (102) for use in developing an electrostatic latent image, formed on an image support member (101) of the apparatus, by transferring developer powder to the latent image, the said image support member (101) being supported at opposite ends thereof in the apparatus by first and second holding members (109, 110).

First and second locating members (116, 117), secured respectively to the said holding members (109, 110), are provided with respective grooves (116a, 117a), for receiving respectively first and second mounting members (115, 114A) disposed at opposite axial ends of the developing roller (102) such that a desired operative positioning of the developing roller (102) in the apparatus can be achieved by inserting the said first and second mounting members (115, 114A) into the said grooves (116a, 117a) at respective first ends thereof and moving those mounting members (115, 114A) along the grooves (116a, 117a) into engagement with abutment portions (116b, 117b) at respective opposite ends of those grooves (116a, 117a).

Since the shaft of the developing roller (102) is itself used to locate the developing unit with respect to the image support member (101), the error in the gap between the developing roller (102) and image support member (101) can be reduced, and/or fitting tolerances relaxed, as compared with prior art printing apparatus. *Fig. 3*



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ELECTROPHOTOGRAPHIC PRINTING APPARATUS

The present invention relates to electrophotographic printing apparatus.

An electrophotographic printing apparatus generally comprises, as its principal components, a photosensitive drum having an image support or forming member made by, for example, a photosensitive layer of amorphous selenium formed on a metallic cylindrical surface; an electrification or charging unit for uniformly charging the surface of the photosensitive drum by corona discharge, etc., to photosensitize the photosensitive drum; an exposing unit to form an electrostatic latent image on the surface of the photosensitive drum thus photosensitized by irradiating a laser beam modulated by information to be recorded; a developing unit for developing the electrostatic latent image, which has been formed by the exposing unit, with toner; a transferring unit for transferring the toner image formed by the developing unit to paper; and a fixing unit for fixing the toner image, which has been transferred to the paper by the transferring unit, through heat melting, etc.

In the developing unit having the above arrangement, the toner, which has an electric charge of opposite polarity to that of the electrostatic latent image formed on the photosensitive drum, is attracted by electrostatic attraction to the latent image. Generally a powdered toner is used, and the powdered toner is mixed with an iron powder, etc., called the "carrier", to provide the powdered toner with the electric charge. This mixture is known as a "two-component developer" or simply a "developer". When the toner and carrier are mixed in the developing unit, frictional charging occurs which provides the electric charge for the developer.

Generally, a mixing ratio of the toner (toner concentration) is expressed by weight percentage, and is, for example, 4%. Since the toner concentration is gradually decreased during use, the toner concentration must be monitored and toner supplied when the toner concentration reaches a predetermined limit.

In the electrophotographic apparatus described above, a layer having a certain thickness of the developer is formed at the periphery of the developing roller by utilising the magnetic action in a known manner. The developing roller is then rotated so that the layer touches the image forming member.

As mentioned above, the toner is transferred from the developing roller to the electrostatic latent image formed on the image support member by electrostatic action, and the attracting force is inversely proportional to the second power of distance.

Therefore, a gap between the image forming member and the developing roller must be precisely maintained at a desired value.

To maintain the gap between the image forming member and the developing roller at a predetermined value, the following structure has been adopted according to apparatus previously considered.

Us-A-4426148 discloses printing apparatus having a removable developing unit including a casing, for holding developer powder, and a developing roller for use in developing an electrostatic latent image, formed on an image support member of the apparatus, by transferring developer powder to the latent image, the said image support member being supported at opposite ends thereof in the apparatus by first and second holding members. In the apparatus of Us-A-4426148, projections provided on the developer unit casing are brought into abutment with corresponding projections on the main body of the apparatus, thereby locating the developing unit relative to the image support member.

However, in addition to having to consider the possibility of positioning errors which may arise through variation in the exact position of the projections on the developer unit casing and the corresponding projections on the main body of the apparatus, variations in the precise position of the developer roller with respect to the casing of the developer unit must also be taken into account.

Owing to the accumulation of these errors, unless the bearings for the developing roller and the projections on the developer unit casing and apparatus body are made and fitted with very high precision, significant errors will arise in the gap between the image support member and the dev l-oping roller.

In another apparatus previously considered, a pair of roller bearings is provided for a casing of the developing unit, and the roller bearings are caused to touch the peripheries of both ends of the image forming member respectively.

In further apparatus previously considered, roller bearings are coaxially disposed at both ends of the developing roller, and the peripheries of the roller bearings are caused to touch the peripheries of both ends of the image forming member.

In these apparatuses, the gap between the image forming member and the developing roller may be changed due to the adhesion of the toner.

Therefore, it is desirable to provide a printing apparatus including a unit in which the gap between the image forming member and the develop-

ing roller is accurately maintained, whilst enabling the roller and casing to be removed or replaced easily when necessary.

According to the present invention there is provided a printing apparatus having a removable developing unit including a casing, for holding developer powder, and a developing roller for use in developing an electrostatic latent image, formed on an image support member of the apparatus, by transferring developer powder to the latent image, the said image support member being supported at opposite ends thereof in the apparatus by first and second holding members; characterised in that first and second locating members, secured respectively to the said holding members, are provided with respective grooves, for receiving respectively first and second mounting members disposed at opposite axial ends of the developing roller such that a desired operative positioning of the developing roller in the apparatus can be achieved by inserting the said first and second mounting members into the said grooves at respective first ends thereof and moving those mounting members along the grooves into engagement with abutment portions at respective opposite ends of those grooves.

Thus, since the shaft of the developer roller is fitted directly to the apparatus, fewer positioning errors can occur and the desired gap between the image support member and developing roller can be achieved and maintained more easily.

Reference will now be made, by way of example, to the accompanying drawings, in which:-

Figs. 1, 2(A) and 2(B) show respective views of a removable developing unit for use in explaining an embodiment of the present invention, Figure 2(B) being a view taken along the line A-A in Figure 2(A);

Fig. 3 shows a view of a positioning structure for use in an embodiment of the present invention;

Fig. 4 is a view taken along the line I-I in Fig. 3;

Fig. 5 is a view taken along the line II-II in Fig. 3;

Figs. 6 to 8 show respective views of a regulating unit, for use in an embodiment of the present invention, in which Figure 6 is useful for explaining the principle of operation of a regulating unit,

Figure 7 shows a perspective, partly-broken, view, and

Figure 8 shows a perspective view, of a portion of the regulating unit;

Figs. 9 and 10 are graphs;

Fig. 11 shows a vertical cross-sectional view of a developing unit in which a positioning structure embodying the present invention can be employed;

Fig. 12 shows a perspective view of a portion of the developing unit of Fig. 11;

Fig. 13 shows a view of another portion of the developing unit of Fig. 11;

Fig. 14 is a diagram for use in explaining a principle of operation of the portion of Fig. 13;

Fig. 15 is a graph;

Fig. 16 shows a side view of the developing unit shown in Fig. 11;

Fig. 17 shows a plan view taken along the line G-G in Fig. 16;

Fig. 18 shows printing apparatus embodying the present invention;

Fig. 19 shows a schematic view of part of the apparatus shown in Fig. 18; and

Fig. 20 is a graph.

The principle of a removable developing unit, for use in an embodiment of the present invention, will now be described with reference to Figs. 1 and 2(A) and 2(B).

In Figure 1 the numeral 101 represents an image support or forming member; 102 a developing roller; 103 a first supporting member disposed at one end of a shaft of the developing roller 102; 104 a second supporting member disposed at the other end of the shaft of the developing roller 103, 109 and 110 a pair of holding members (side frames) for holding the image forming member 101; 107 a first fitting member which is fixed to one (109) of the holding members to fit the first supporting member 103 thereto; and 108 a second fitting member which is fixed to the other holding member 110 to fit the second supporting member 104 thereto.

In the developing unit of Fig. 1, the accumulation of dimensional errors is reduced by providing only two members, i.e. the holding member 109 (or 110) and the fitting member 107 (or 108), which are interposed between the image forming member 101 and the developing roller 102. The periphery of the image forming member 101 to which the developer tends to adhere is not used for positioning, thereby improving the accuracy of a gap between the image forming member 101 and the developing roller 102.

In Figures 2(A) and 2(B) a similar developing unit is shown, the unit having a rotary sleeve type magnetic developing roller. In the Figure, the reference numerals shown in Fig. 1 represent like parts, and, further, the numerals 111 and 112 represent roller bearings fixed to holding members 109 and 110 to support a rotary shaft of an image forming member 101; 113 a driving gear provided at one end of a shaft of the image forming member 101; 114 a guide pin provided on a stationary magnet side, having a first mounting member 114A and being provided on one side of a shaft of a developing roller 102; 115 a roller bearing provided on a rotary sleeve side, the roller bearing 115 being a

second supporting member on the other side of the shaft of the developing roller 102; 116 a first locating member or stopper fixed to the holding member 109, the first stopper 116 being a fitting member to receive the guide pin 114; 117 a second locating member or stopper fixed to the holding member 110, the second stopper 117 being a fitting member to receive the roller bearing 115 therein; 118 a developing unit casing; and 119 a driving gear for driving a sleeve of the developing roller 102.

In the above arrangement, the image forming member 101 is supported by a pair of the holding members 109 and 110 through the high-precision roller bearings 111 and 112.

Therefore, simply by fixing the first and second stoppers 116 and 117 to a pair of the holding members 109 and 110 by precision positioning pins, etc., the developing roller 102 can be positioned with high accuracy with respect to the image forming member 101.

Since the guide pin 114 and the roller bearing 115 are disposed outside the developing unit casing 118, they will not be contaminated by the developer.

As described in the above, the positioning structure can maintain a desired gap between the image forming member and the developing roller with high accuracy so that the recording quality will be stable.

A developing unit for use in an embodiment of the present invention will now be described in more detail with reference to Figures 3, 4 and 5.

The developing unit casing 118 accommodates the developing roller 102, a stirring roller 126 comprising a screw (which will be described later), and a toner supplying roller 127 for supplying the toner from a hopper (not shown) located above the casing 118 to the casing 118. The shaft 114 of the developing roller 102 is fixed to a magnetic roller (to be described later) disposed inside the developing roller 102 and not rotatable with respect to the developing unit casing 118. Another shaft 130 of the developing roller 102 is connected to an outer sleeve of the developing roller 102 and is rotatable with respect to the casing 118 through a bearing 128. Around the shaft 130 within the casing 118, there is provided a seal 125 for preventing the toner from entering the bearing 128. The shaft 130 is received in a guide groove 117a (Fig. 4) of the stopper 117 through the bearing 115. The stopper 117 is fixed to the side frame 110 to position precisely an end or abutment portion 117b (against which the bearing 115 abuts) of the guide groove 117a at a location spaced from a shaft 129 of the photosensitive drum 101 by a predetermined distance. A driving shaft 131 passes through the stopper 117, and a gear 124 fitted to the driving shaft 131 engages with the gear 119 fixed to the shaft 130 of the developing roller to drive it in rotation. A pulley 123 is fixed to the shaft 131 outside the side frame 110 and connected to a motor 121 through a proper means such as a belt and a gear. The numeral 122 represents a gear box. The motor 121 also drives a pulley 113 fixed to the shaft 129 of the photosensitive drum 101 through a timing belt 120, thereby driving the photosensitive drum 101.

Similar to the stopper 117, the other stopper 116 is provided with a guide groove 116a having an end or abutment portion 116b against which the mounting member 114A on the shaft 114 of the developing roller 102 abuts (Fig. 5). To maintain a distance "L", between the guide groove end portion 116b of the stopper 116 and the shaft 129 of the photosensitive drum 101, at a predetermined value, the stopper 116 is fixed with high accuracy to the side frame 109.

According to the above arrangement, the developing unit is inserted into a printing apparatus in a direction indicated by an arrow mark P, and the shafts 114 and 130 (or rather the first and second mounting members 114A, 115) of the developing roller are received in the guide grooves 116a and 117a of the stoppers 116 and 117 respectively to reach the end portions 116b and 117b respectively. In this state, the developing unit is held in such a way as to maintain a gap G (Fig. 5), between the surface of photosensitive drum 101 and the surface of the developing roller 102, at a desired value, whilst allowing the developing roller 102 to be removable, without difficulty, when necessary.

A regulating unit, for use in apparatus embodying the present invention, will now be described with reference to Figures 6 to 10. The regulating unit concerned in the subject of European Patent Application No. 86305134.8, out of which the present application was divided.

In some previously-proposed electrophotographic recording apparatus which allow the us of several kinds of papers having different widths, the toner concentration in the developing unit can become nonuniform in a paper width direction if papers having a width narrower than the maximum width are used for a long time, and subsequently, if a paper having a width wider than the width of those papers is used, a difference in the recording density will occur in the direction of the paper width of the wider paper. Accordingly, the printing apparatus is provided with a regulating unit.

Figure 6 shows a view for use in explaining the principle of the regulating unit. In the Figure, the numeral 9 represents a stirring roller or screw provided with paddles or grooves each having a helix angle with respect to an axis of the screw, the screw transferring developer powder stored in a developer reservoir 2 towards (arrow mark A) and

axially along (arrow mark E) the surface of the developing roller 4 to supply the powder developer for the developing roller 4; 7″ a powder guidance member or flow regulating plate for biasing a stream (arrow mark C) of the powder developer, which has been removed by the regulation of a blade 6 and which is moving, due to the action of gravity, in a direction (arrow mark D) opposite to the direction (arrow mark E) in which the powder developer is transferred by the screw 9. The flow regulating plate 7″ is provided with a plurality of biasing fins each of which is inclined with respect to an axis of the screw 9 as will be described later.

Namely, the developer stored in the developer reservoir 2 is transferred in the direction of arrow mark A to be supplied to the developing roller 4, and the developer biased in the direction of arrow mark D by the flow regulating plate 7″ is fed back in the direction of arrow mark E.

A regulating unit which operates in accordance with the principle described above is known per se from EP-A-0125497.

The provision of a stirring roller and powder guidance member, such as provided in EP-A-0125497, serve to some extent to redistribute developer powder to provide a more uniform application to the developer roller. However, this regulating unit has been found to be capable of improvement.

Figure 7 shows a perspective, partly-broken, view of a regulating unit for use in an embodiment of the present invention. A screw 9 is provided with a plurality of paddles each having a helix angle with respect to an axis of the screw 9. The screw rotates in a direction indicated by arrow mark A to transfer powder developer stored in a developer reservoir 2 in a direction indicated by arrow mark E and in a direction indicated by arrow mark A toward the circumference of a developing roller 4 to supply the powder developer to the developing roller 4.

A flow regulating plate 7″ is provided with a plurality of fins 7a each being inclined with respect to an axis of the developing roller 4 similar to the guide plate 7 shown in the first-considered example. As a result, the developer which has been removed by the regulation of a blade 6 and is returning to the developer reservoir 2 is biased in a direction indicated by arrow mark D.

An example of the screw 9 is shown in Fig. 8, in which the screw 9 is provided with eight paddles 9a each of which is twisted by 180° for the total length (about 28 cm) of the screw 9.

Figure 9 is a graph showing the relationship between helix angles and transferring forces circumferentially and axially of the screw with respect to the change of the number of paddles of the screw. An ordinate axis indicates the amount transferred in a circumferential direction (the higher up the ordinate axis in Fig. 9, the larger the amount) of the toner which is scooped by the screw and supplied to the developing roller, as well as the amount (the lower down the ordinate axis, the larger the amount) of the toner which is returned in an axial direction of the screw after the toner is fed back from the developing roller. An abscissa axis indicates helix angles. In this case, each helix angle value indicates the degree of twist of each paddle with respect to the whole length of the screw (which is about 28 cm, similar to the whol length of the developing roller). An area between straight lines "a" and "b" shown in the graph is the one in which the helix angle causes the amounts transferred in the circumferential and axial directions to balance. This area will be defined as follows:

If a single paper having a width which is the same as the total axial length of the developing roller is printed after printing 1000 papers each having a width of a half of the total axial length of the developing roller, a difference in printed density between a portion of the single paper which has been printed by one half of the developing roller used for printing the 1000 papers, and the other portion of the single paper which has been printed by the other half of the developing roller not used for printing the 1000 papers is within 0.2 of the OD value.

In the area between the lines "a" and "b", th toner is stirred uniformly for the whole length of the developing roller, and the difference in printing density is so small that it can be ignored in practical use. As apparent from the graph, an optimum constitution will be realized with eight paddles each having a helix angle of 180°.

The screw 9 allows any nonuniformity of the concentration of developer in an axial direction of the developing roller to be greatly reduced without hastening the deterioration of the developer and without increasing the number of parts as compared with previously-proposed regulating units.

Figure 10 is a graph showing a balance between an amount of toner returned from the developing roller guided by the fins and the amount of toner transferred by the screw in an opposite direction to the biased direction, with respect to the inclination angle of each fin. An area between straight lines "c" and "d" shown in the graph is the one in which the balance between the amounts transferred by the fins and the screw become optimum, and the toner is uniformly distributed over all the developing roller. The graph has been prepared subject to the screw of eight paddles each having a helix angle of 180°. As apparent from the graph, an optimum inclination angle of each fin is 40° to 50°.

A developing unit for use in an embodiment of the present invention, in which developer stored in

a developer casing can be easily replaced, will be described hereunder with reference to Figures 11 to 20. The developing unit concerned is the subject of another European patent application (number not yet known) divided out of application No. 86305134.8.

Figure 11 is a vertical cross-sectional view showing a developing unit 216 for use in an embodiment of the present invention. A toner cartridge 202 containing fresh toner is disposed above a developer unit casing 201. Under the toner cartridge 202, there is provided a toner supplying roller 203 for supplying the toner to the developer casing 210. A stirring roller 204 (i.e. the above-described screw) and a developing roller 205 are disposed in the developer unit casing 201. The stirring roller 204 rotates in a direction indicated by an arrow mark C to supply the toner (not shown) to the peripheral surface of developing roller 205. The peripheral surface of developing roller 205 comprises a rotary sleeve (to be described later) which rotates in a direction indicated by an arrow mark B to supply the toner onto a photosensitive drum (not shown) through an opening 208. The numeral 206 represents a blade for regulating the thickness of toner on the developing roller 205; and 207 a fin for biasing the toner, which has been removed by the blade 206, in a predetermined direction and returning it toward an axis of the stirring roller 204. The developing unit 216 is removably fitted to the apparatus and is provided with a fitting piece 215 which is fixed to a frame of the apparatus. A magnetic roller (to be described later) disposed inside the developing roller 205 is fixed immovably with respect to the developer casing 201. A minimum magnetic force portion of the magnetic roller is arranged to face substantially vertically downward as indicated by an arrow mark A. A selectively openable outlet or cover 209 is disposed under the developing roller 205 to extend substantially for the whole length of the developing roller 205. The periphery of cover 209 is formed in a step 210 (Fig. 12) to constitute a labyrinth or mating structure which is fitted to the periphery of an opening 201a formed at the bottom of casing 201 to completely prevent the toner from leaking. The cover 209 is fixed to the casing 201 by screws 244 through fitting pieces 245. A magnetic sensor 260 for detecting the toner concentration is fitted to the cover 209. The magnetic sensor 260 is connected to a driving portion of the toner supplying roller 203. It is preferable to locate the magnetic sensor 260 at a position between the developing roller 205 and the stirring roller 204 as will be described later.

Figure 13 is a view showing the construction of the developing roller 205. A magnetic roller 211 (magnetic structure) magnetized at a plurality of predetermined positions and fixed at both its ends to fixed shafts 212a and 212b. The sleeve 213 is rotatably fitted to the fixed shafts 212a and 212b through bearings 261 and 262. The sleeve 213 surrounds the peripheral surface of magnetic roller 211. The numeral 263 represents a seal. A driving shaft 264 is fixed to the sleeve 213, and a driving gear 214 is fitted to the driving shaft 264. The shafts 212a and 264 and a gear 214 correspond to the shafts 114 and 130 and the gear 119 shown in Fig. 3 respectively.

Figure 14 is a diagram showing an example of a magnetized state of the magnetic roller 211, and Fig. 15 a waveform diagram showing magnetic force. As shown in Fig. 14, a plurality of N and S poles (N_1 , N_2 , and S_1 to S_3) are magnetized on the magnetic roller 211 with predetermined intervals α_1 to α_5. In this case, a minimum magnetic force portion appears between the poles S_2 and S_3 as apparent from Fig. 15. The minimum magnetic force portion is caused to face substantially vertically downward as indicated by the arrow mark A (Fig. 11).

As shown in Fig. 11, the cover 209 is arranged to face the minimum magnetic force portion. When the toner is to be replaced, the developing unit 216 is removed from the printer, and the cover 209 is opened to discharge the toner at the bottom of the casing. At this time, if the sleeve 213 is rotated by operating manually the driving gear 214 (Fig. 13) of the developing roller 205, the toner remaining on the sleeve will leave the sleeve at a lower position where the magnetic force is weak and be discharged from the casing. Further, if the developing roller driving gear 214 is connected to the stirring roller 204 through a proper gear means, the stirring roller 204 is rotated together with the developing roller by operating the developing roller driving gear 214. Accordingly, the toner remaining at the bottom of the casing is scooped by the stirring roller 201 to be supplied to the circumference of developing roller 205, and as mentioned above, the toner leaves the roller at the lower position where the magnetic force is weak, to be discharged from the casing.

Figure 16 is a view showing the developing unit 216 fitted to a printer. The developing unit 216 is mounted on a frame 217 on the printer side. The reference mark "F" indicates an inserting direction of the developing unit, and "E" the removing direction thereof. As described above, the developing unit 216 is positioned at a predetermined location by abutting the shaft 205a of the developing roller against the stopper 220 on the printer side. A plate 218 having a hole 219 is disposed at an end portion of the frame 217. The fitting piece 215 of developing unit 216 is inserted into the hole 219 to fix the developing unit 216 to the printer. The developing unit 216 can move up and down in a

direction indicated by an arrow mark D with the developing roller shaft 205a being the centre of the movement.

Figure 17 is a view taken along the arrow marks G-G showing the frame on the printer side shown in Fig. 16. The reference marks 217a and 217b represent side frames. The numeral 222 represents a developing unit driving gear which is connected to a motor (not shown) through a belt 221.

Figure 18 is a view showing the construction of a laser printer, having the developing unit 216 described above, which embodies the present invention. At a paper supplying portion 237, printing papers 236 are taken out one by one by a pick roller 235 and supplied to the printer. Around a photosensitive drum 231, there are successively disposed a uniform charging unit 232; a latent image forming unit 234 for forming a latent image on the photosensitive drum 231 with a laser beam 233; the developing unit 216, as described above, for developing the latent image by supplying toner thereto; a transfer charge unit 238 for transferring the toner image onto the printing paper; a separation charge unit 242; a cleaner 239; and a discharging unit 234. The numeral 240 represents a fixing unit, and 241 a stacker for stacking printed papers.

Figures 19 and 20 are views showing fitting positions of the toner concentration sensor of the developing unit in an embodiment of the present invention. To obtain a constant printing quality, the toner concentration should be maintained at a constant value. The achieve this, the toner concentration sensor detects the toner concentration status, and the toner is supplied or replaced if the concentration is lowered. Figure 19 is a schematic view showing the developing unit. The arrow marks A and 5 indicate the flow of toner 330. The numeral 301 represents a photosensitive drum; 321 a stirring roller; 322 a developing roller; 332 a blade; and 324 a toner biasing plate. A toner concentration sensor 331 is disposed at the bottom of a casing 340 and between the developing roller 322 and the stirring roller 321. At this position, the toner from the developing roller and the toner from the stirring roller are mixed and always flow uniformly. Therefore, a highly reliable toner concentration detection will be performed at this position, because erroneous detection due to the turbulence of the flow of toner or due to the nonuniformity of concentration caused by a difference of the toner consumption at various locations of the developing roller is prevented.

Figure 20 is a graph showing the relationship between the toner concentration C_r and an analog output of the sensor with respect to various installation positions of the toner concentration sensor. In the graph, curves A, B, C, and D correspond to installation positions which are shown in the right upper side of the graph to have the same reference marks respectively.

From the graph, the following is apparent:

In the case of curve B according to the present invention, the inclination of C_r to analog output is steep so that a change in the concentration can be accurately detected.

In the case of curve A, the total quantity of toner at the sensor installation position is small so that the detection may be difficult to perform.

In the cases of curves C and D, owing to the large influence of the paddles of the stirring roller the analog output varies considerably so that the adjustment may be difficult to perform. Further, the inclination of C_r to analog output is decreased so that a highly accurate detection will not be realized.

At a position E, the flow of toner is not stable due to a blade 323 causing turbulence in the flow, so that a reliable detection will not be realized.

Therefore, the most reliable concentration detection will be performed when the sensor is arranged at the position B.

Claims

1. A printing apparatus having a removable developing unit including a casing (118), for holding developer powder, and a developing roller (102) for use in developing an electrostatic latent image, formed on an image support member (101) of the apparatus, by transferring developer powder to the latent image, the said image support member (101) being supported at opposite ends thereof in the apparatus by first and second holding memb rs (109, 110);
characterised in that first and second locating members (116, 117), secured respectively to the said holding members (109, 110), are provided with respective grooves (116a, 117a), for receiving respectively first and second mounting members (115, 114A) disposed at opposite axial ends of the developing roller (102) such that a desired operative positioning of the developing roller (102) in the apparatus can be achieved by inserting the said first and second mounting members (115, 114A) into the said grooves (116a, 117a) at respective first ends thereof and moving those mounting members (115, 114A) along the grooves (116a, 117a) into engagement with abutment portions (116b, 117b) at respective opposite ends of those grooves (116a, 117a).

2. Apparatus as claimed in claim 1, wherein end portions of the said first and second mounting members (115, 114A) are located outside the said developer casing (118).

3. Apparatus as claimed in claim 1 or 2,

wherein a shaft (130) of the developing roller (102) is driven by a gear mechanism (119, 124, 131).

4. Apparatus as claimed in any preceding claim, wherein the said developing roller (102) is mounted on one of the said first or second locating members (117) by means of a bearing (115).

5. Apparatus as claimed in any preceding claim, including a powder developer regulating unit comprising:

a stirring roller (9) provided with a plurality of paddles (9a) each extending substantially the full length of the roller along a helical path around its axis, which roller is rotatable about its axis to transfer developer powder stored in a developer reservoir (2) of the unit, when it is in use, towards and axially along the surface of the said developer roller (4), the paddles (9a) of the said plurality being eight in number, one axial end of each paddle being displaced about the axis of the stirring roller (9) by an angle in the range from 120° to 240° in relation to the other axial end of that paddle;

a powder blocking element (6) arranged so as to regulate the thickness of a layer of said developer powder that is brought into contact with the said image support member by said developing roller (4) when the unit is in use; and

a powder guidance device (7) arranged to impose on a stream of the developer powder, which has been removed from the developing roller by the action of said blocking element (6) and which is returning to said developer reservoir under the influence of gravity, a component of motion in a direction opposite to that in which the developer powder is transferred axially along the surface of the developing roller by said stirring roller; the angle of displacement of each paddle (9a) being such that the rate of transference of developer powder by the said stirring roller (9) from the said developer reservoir (2) is substantially equal to the rate of transference of developer powder to the said developer reservoir (2).

6. Apparatus as claimed in claim 5, in which the angle of displacement is substantially 180°.

7. Apparatus as claimed in claim 5 or 6, wherein said powder guidance device (7) is provided with a plurality of fins (7a) each being inclined by an angle in the range from 40° to 50° with respect to the axis sof said stirring roller (9).

8. Apparatus as claimed in any preceding claim, in which the developing roller is of the type having a rotatable sleeve (213) surrounding a magnet structure (211) that is fixed relative to the said casing (201) and is such that developer powder is held magnetically on the said sleeve (213) over upper regions thereof, when the apparatus is in use, but is allowed to fall from a lower region (α_3) of the sleeve (213), wherein the said casing includes a selectively openable outlet (209), positioned so as to be substantially below the said lower region (α_3) when the apparatus is in use, for facilitating removal of unwanted developer powder from the casing (201).

9. Apparatus as claimed in claim 8, wherein a peripheral portion of the said selectively openable outlet (209) is stepped (210) so as to mate with a correspondingly stepped portion of said developer casing.

10. Apparatus as claimed in any one of claims 5 to 9, wherein a toner concentration sensor for controlling the toner concentration of the developer powder is arranged at a lower region of the developer casing and between the developing roller and the stirring roller.

11. Apparatus as claimed in any preceding claim, further comprising locking means for locking the developing unit onto the frame of the apparatus, the locking means comprising a fitting piece (215) secured to a front side face of the casing of the unit and adapted to fit into a corresponding aperture (219) provided in the frame in such a way as to be slidably movable in the aperture so that the unit can move up and down so as to pivot about the shaft of the developing roller disposed at the rear side of the unit.

12. Apparatus as claimed in any preceding claim, in which the developing unit is such that used developer powder is discarded therefrom when the unit is removed from the apparatus.

13. Apparatus as claimed in any preceding claim, which further comprises a latent image forming unit (234) for forming a latent image on th image support member; a transfer electrification unit (238) for transferring the latent image onto printing paper; a separation electrification unit (242); a cleaner (239) and a discharging unit (243).

14. Apparatus as claimed in claim 13, in which the latent image forming unit (234) comprises means for modulating a laser beam with image information.

Fig. 1

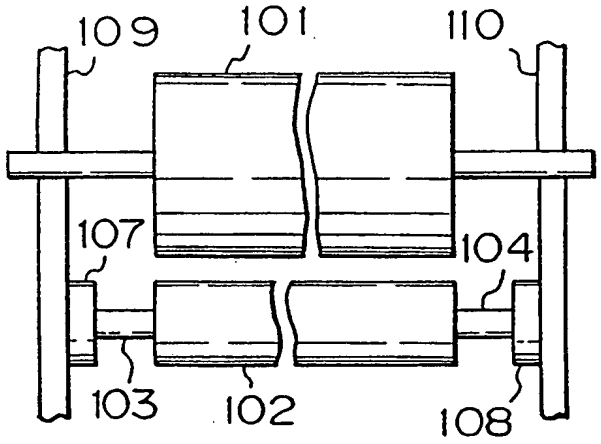


Fig. 2(A)

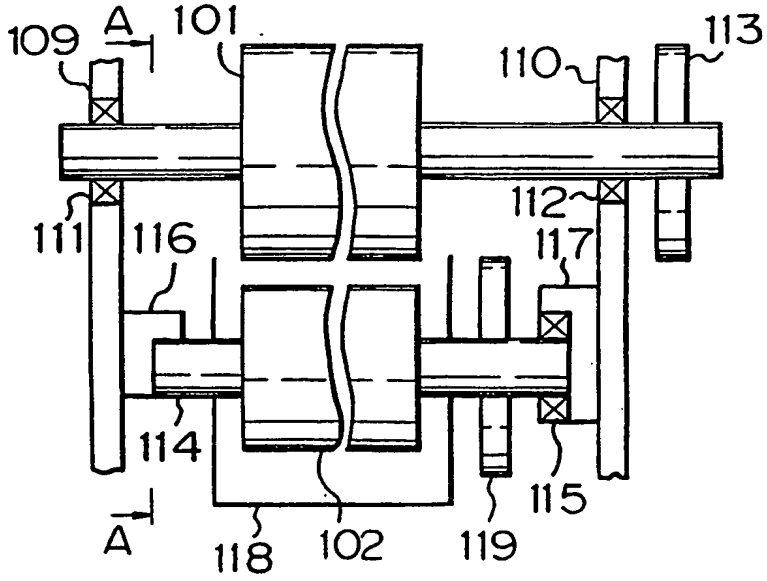


Fig. 2(B)

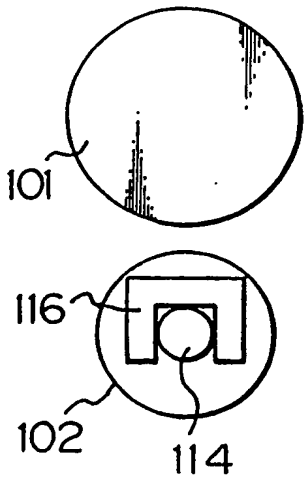


Fig. 3

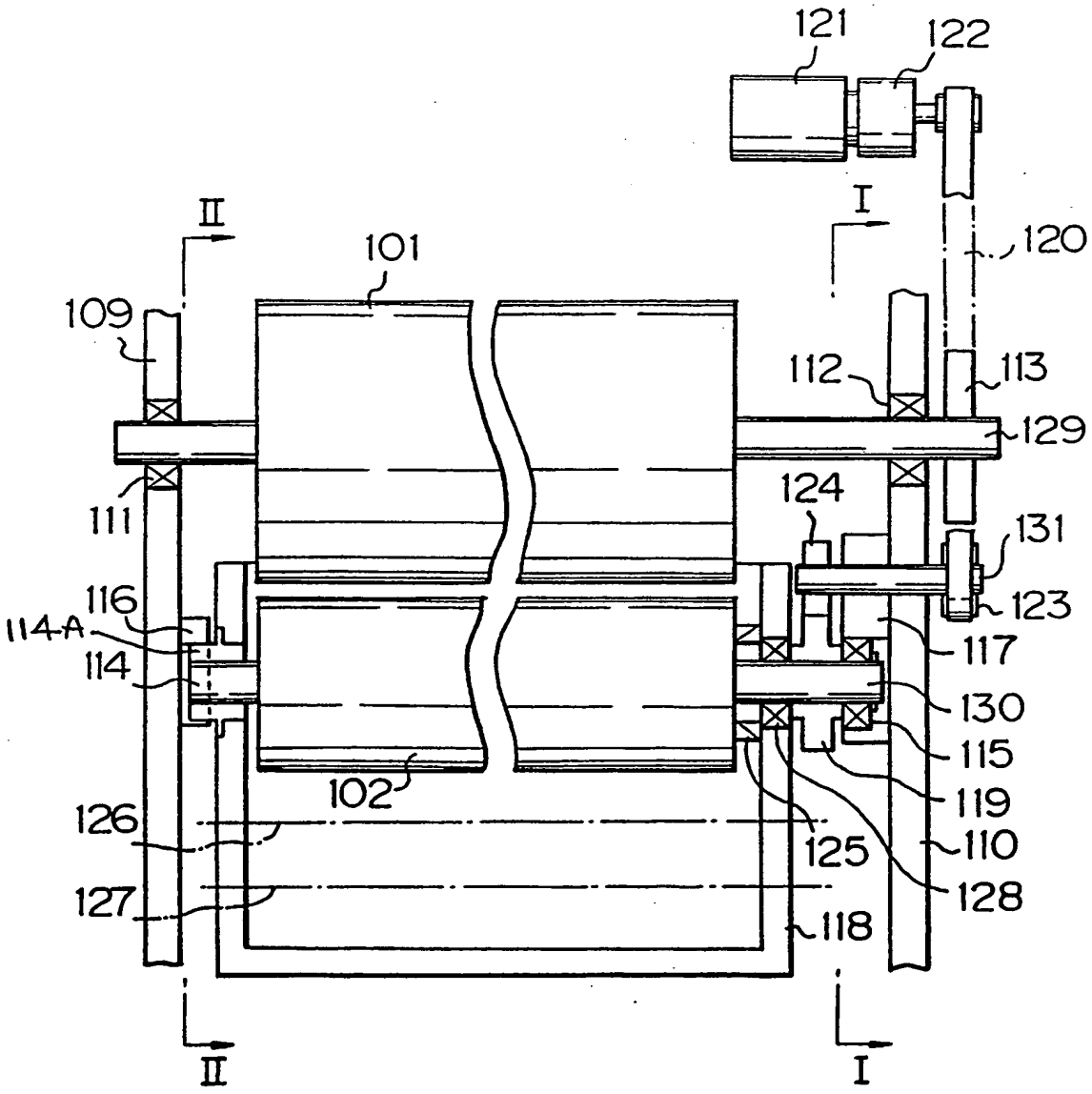

121
122
II
I
101
120
109
112
113
129
111
124
131
116
123
114-A
117
114
130
115
102
119
126
125
110
127
128
118
II
I

Fig. 4

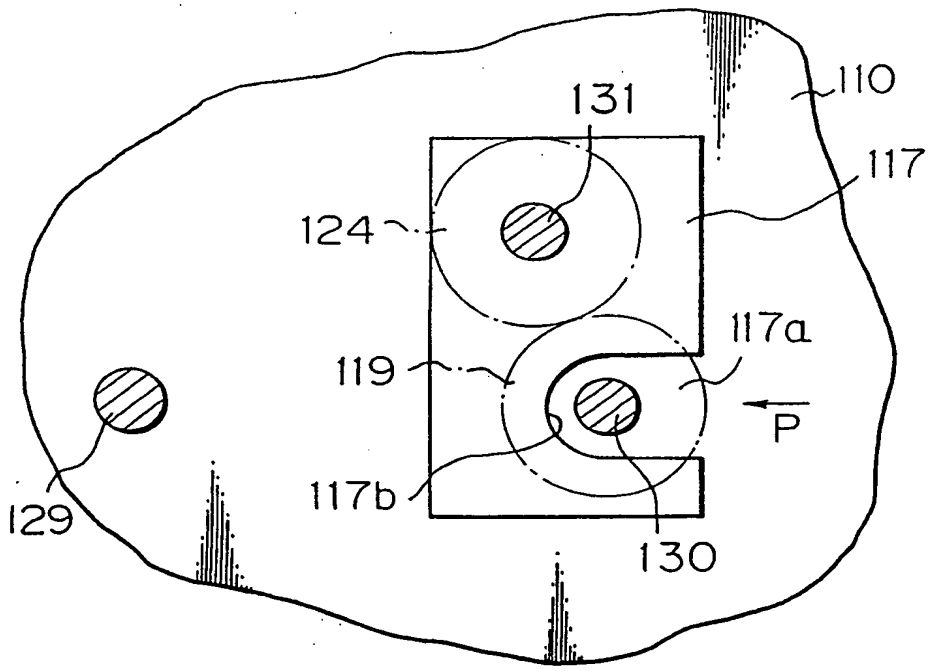

131
110
117
124
117a
119
P
129
117b
130

Fig. 5

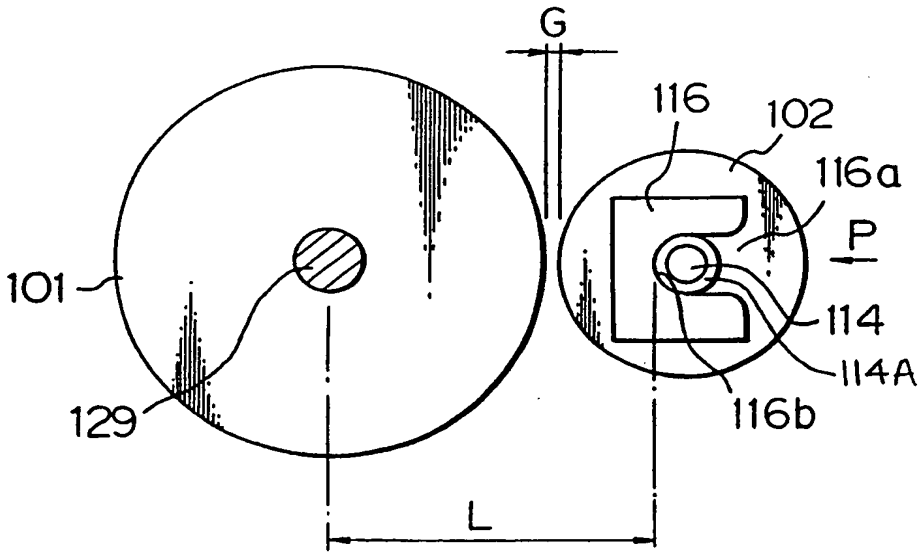

G
116
102
116a
P
101
114
114A
129
116b
L

Fig. 6

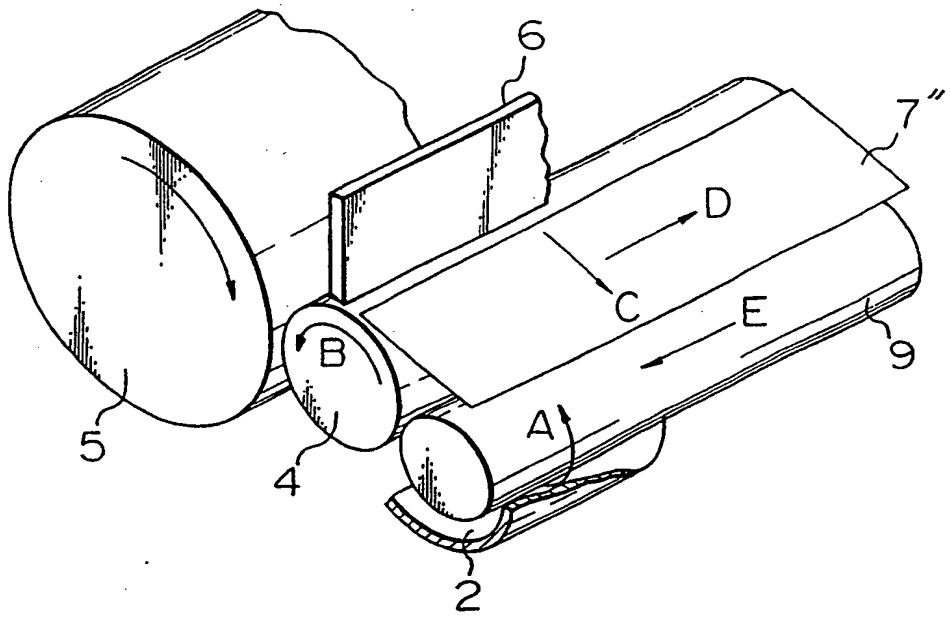


Fig. 7

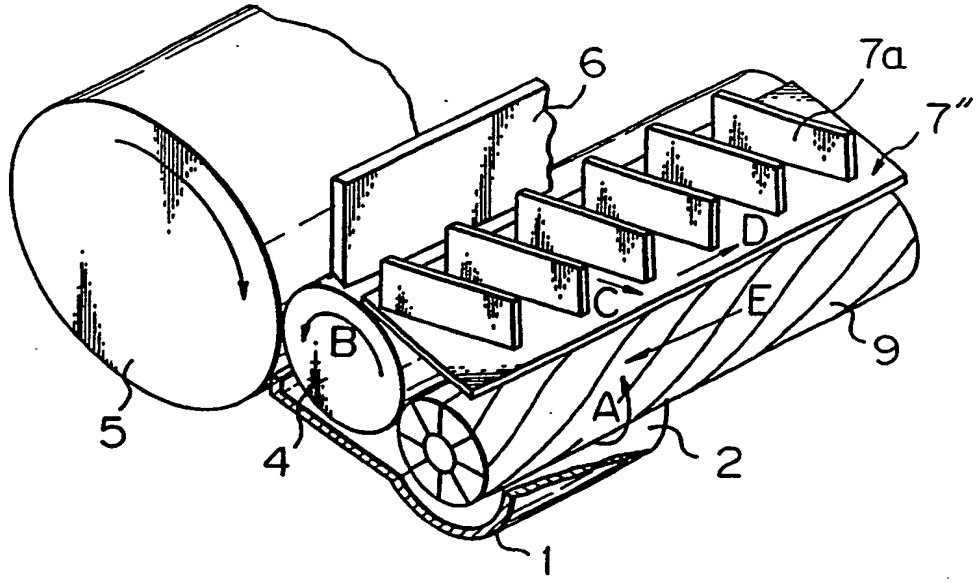


Fig. 8

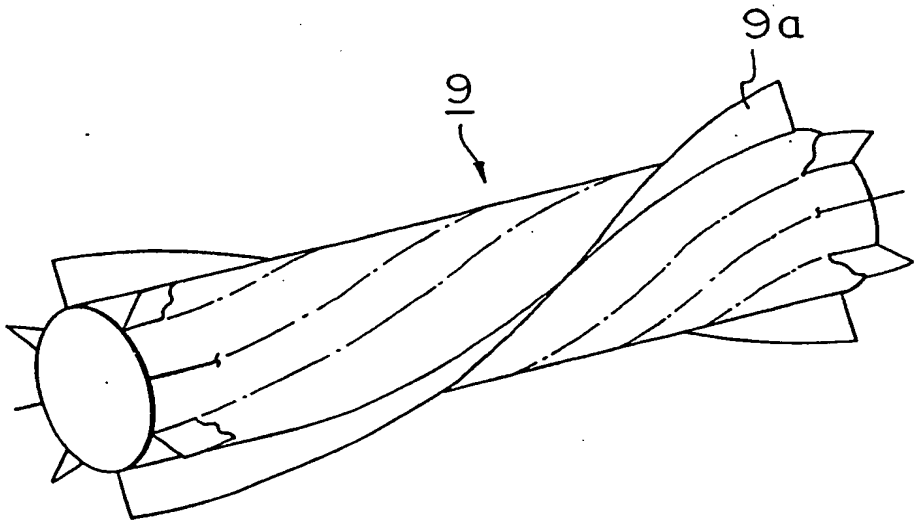


Fig. 9

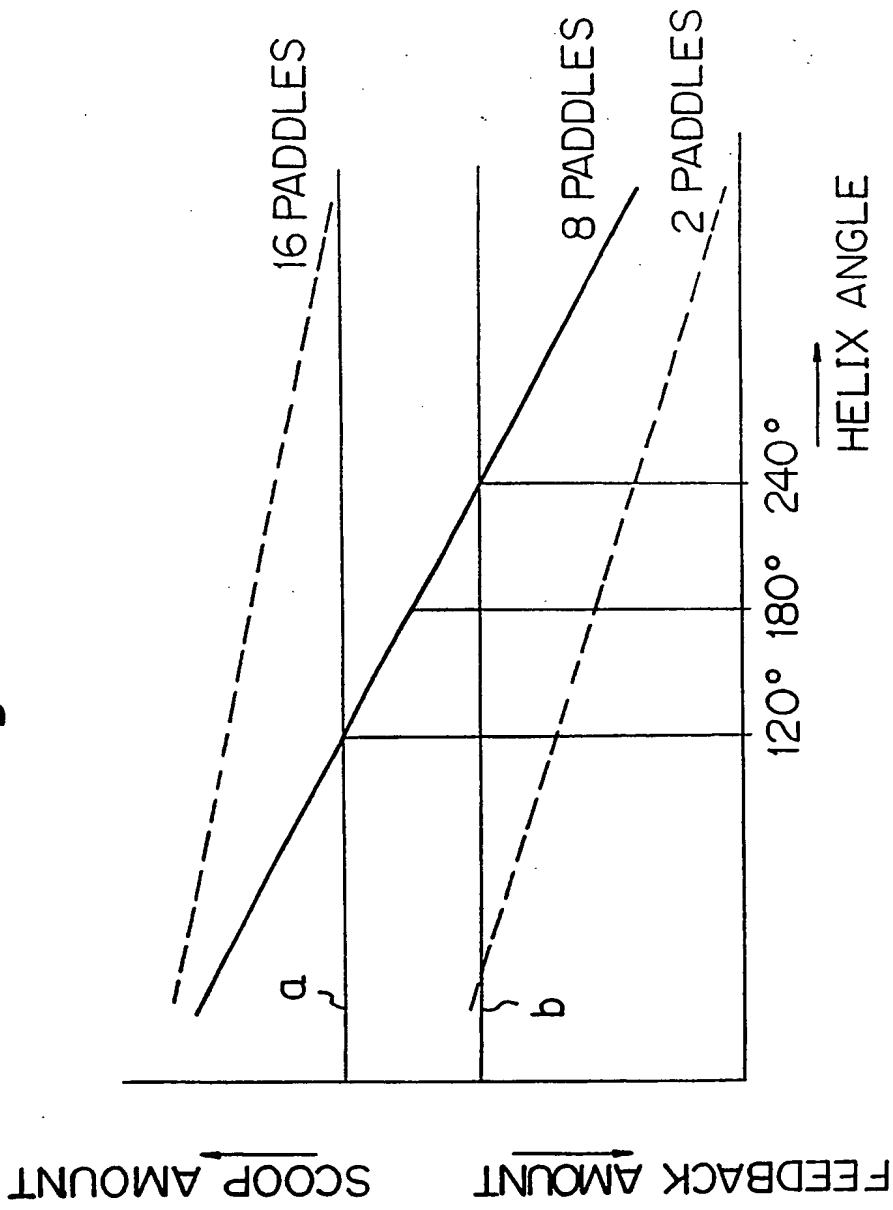

16 PADDLES
8 PADDLES
2 PADDLES
HELIX ANGLE
120° 180° 240°
a
b
SCOOP AMOUNT
FEEDBACK AMOUNT

Fig. 10

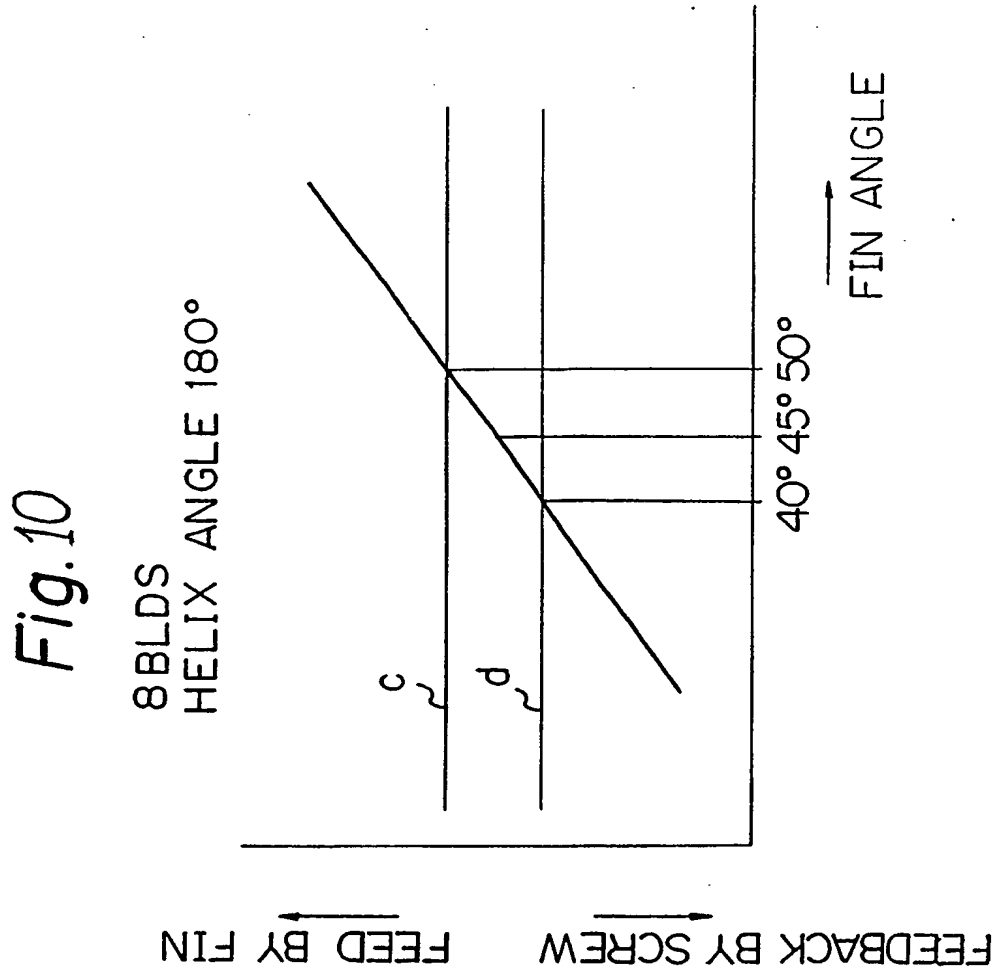

8 BLDS
HELIX ANGLE 180°
c
d
40° 45° 50°
FIN ANGLE
FEEDBACK BY SCREW
FEED BY FIN

Fig. 11

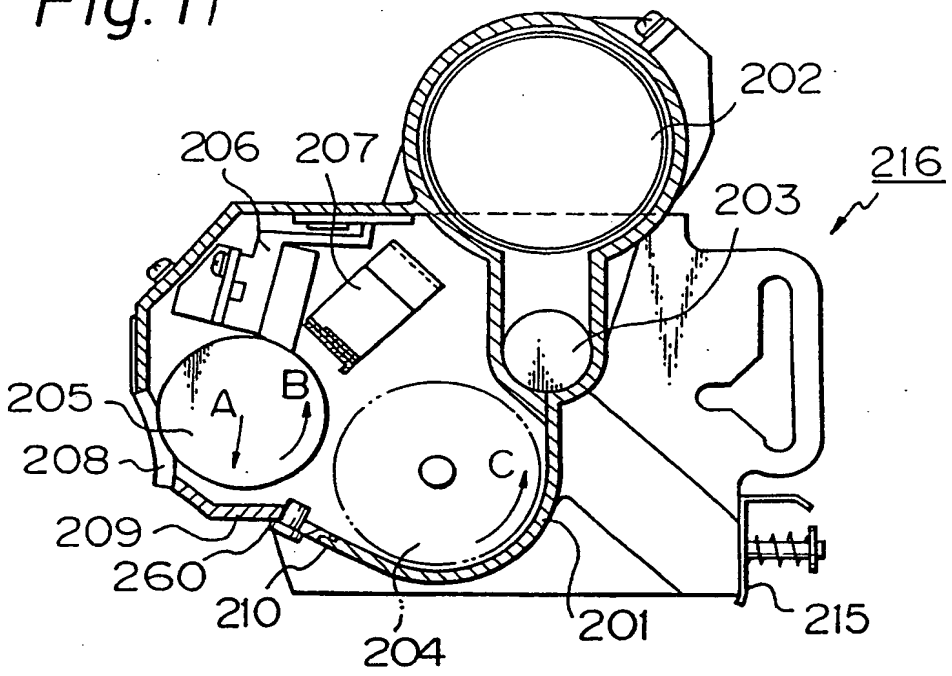

202
206
207
216
203
205
A
B
208
C
209
260
210
204
201
215

Fig. 12

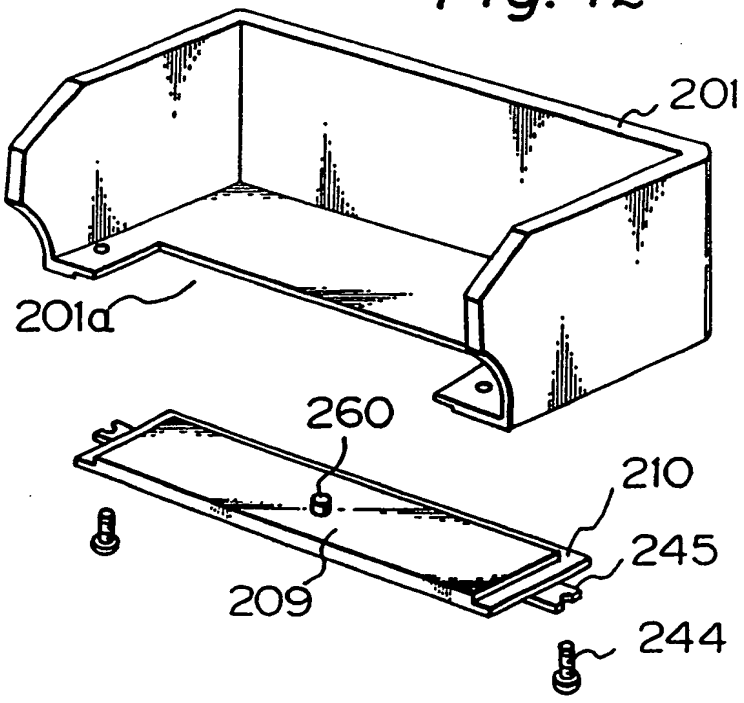

201
201a
260
210
245
209
244

Fig. 13

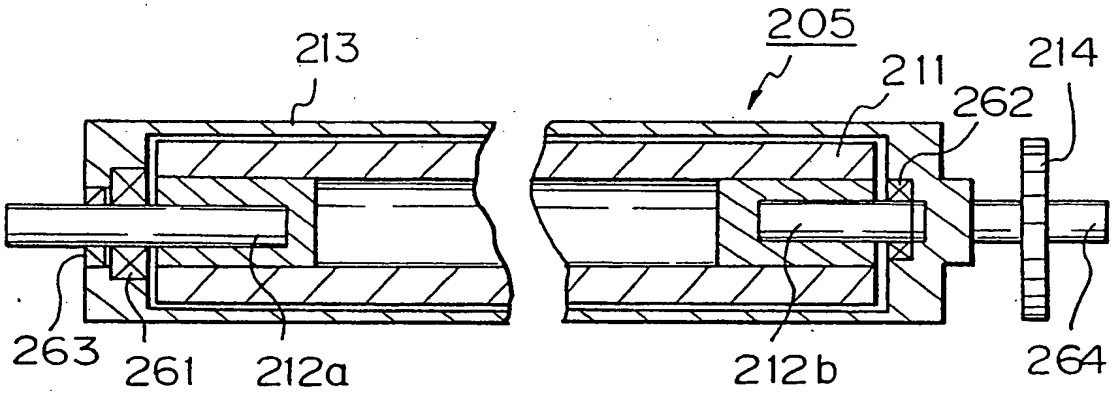

213
205
211
214
262
263
261
212a
212b
264

Fig. 14

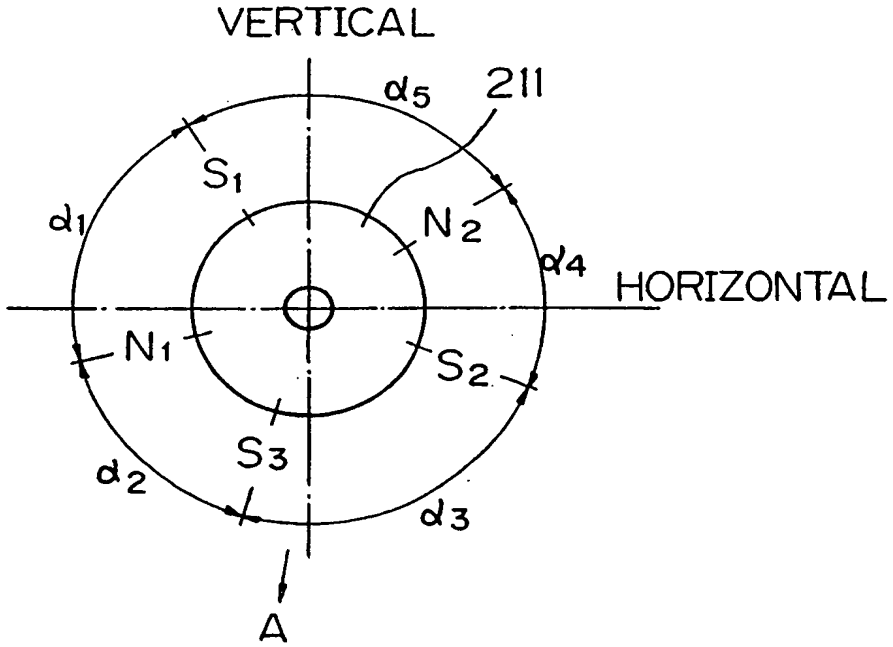

VERTICAL
α5
211
S1
α1
N2
α4
HORIZONTAL
N1
S2
S3
α2
α3
A

Fig. 15

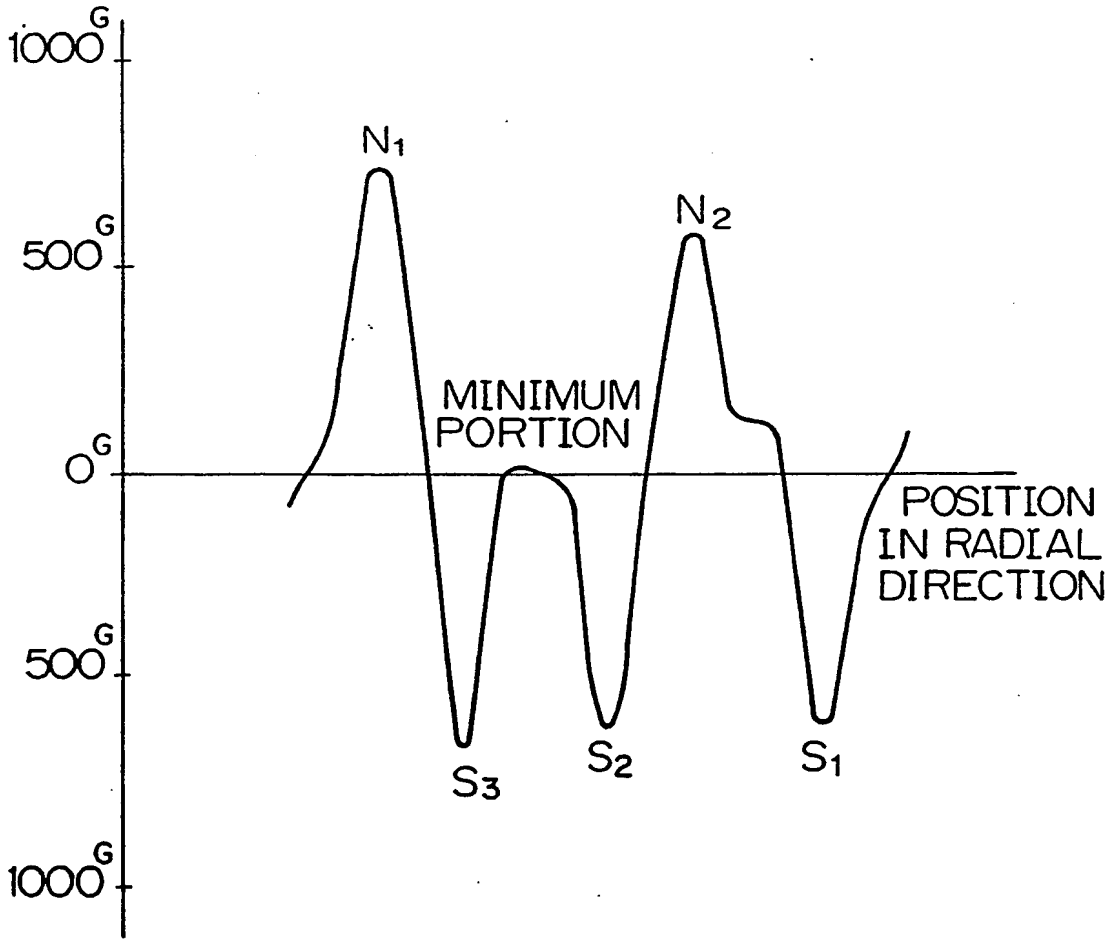

1000 G
500 G
0 G
500 G
1000 G
N1
N2
MINIMUM PORTION
S3
S2
S1
POSITION IN RADIAL DIRECTION

Fig. 16

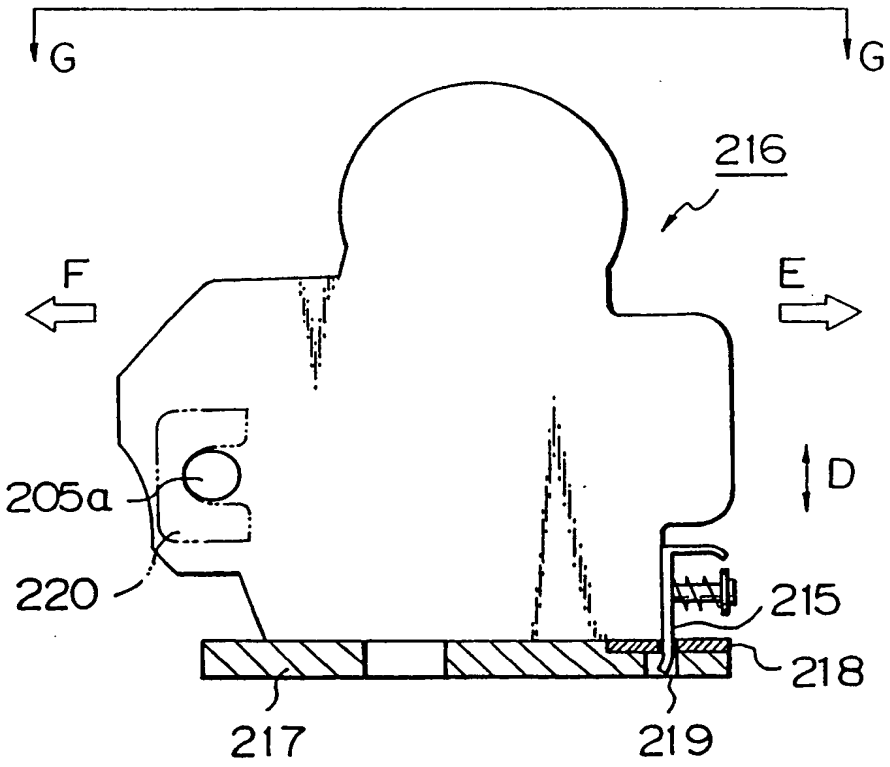


Fig. 17

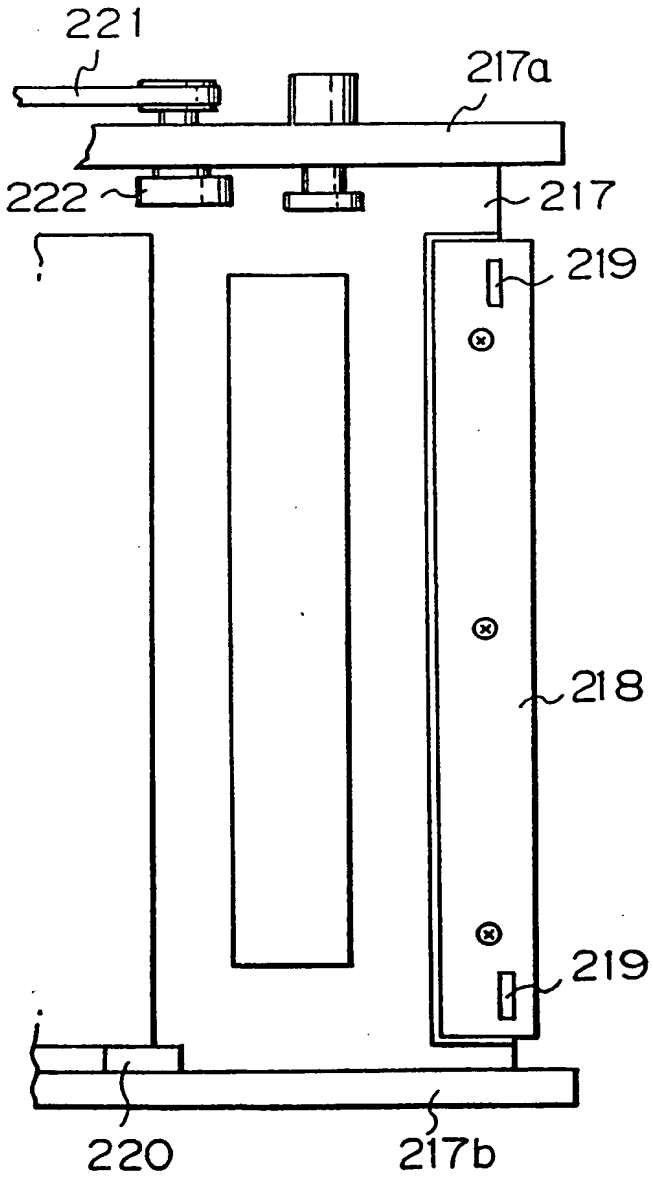


Fig. 18

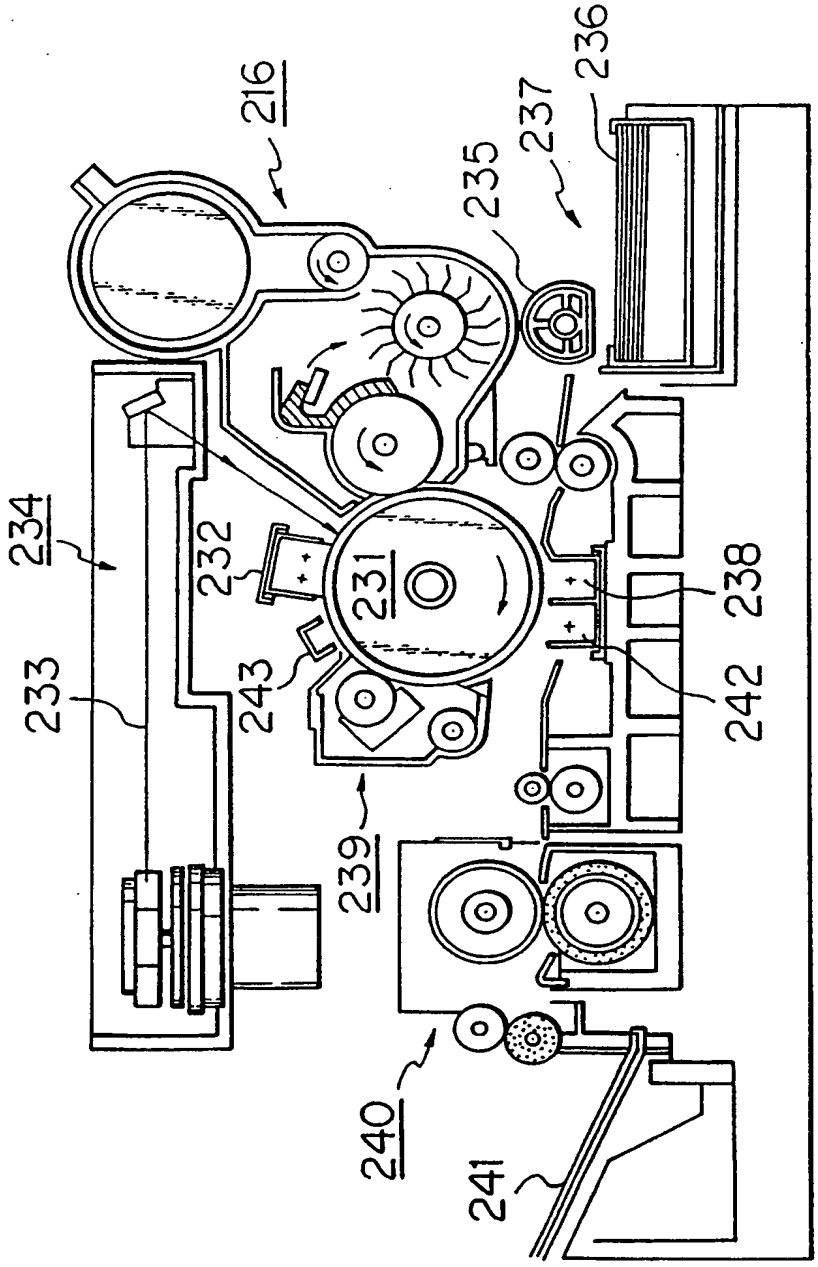
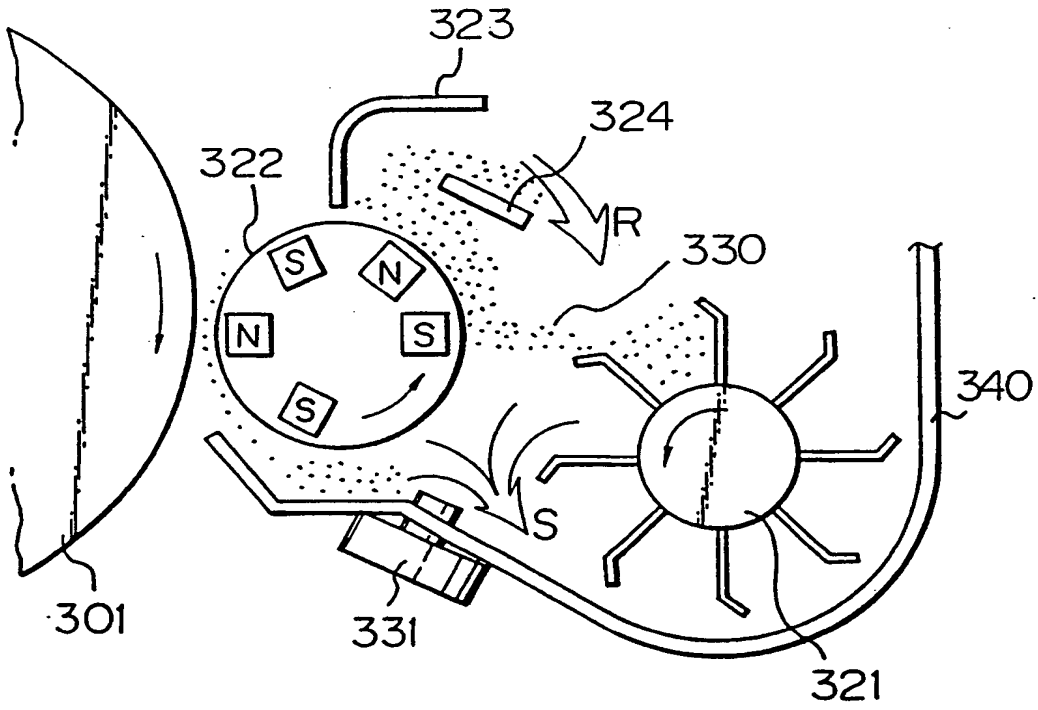


Fig. 19



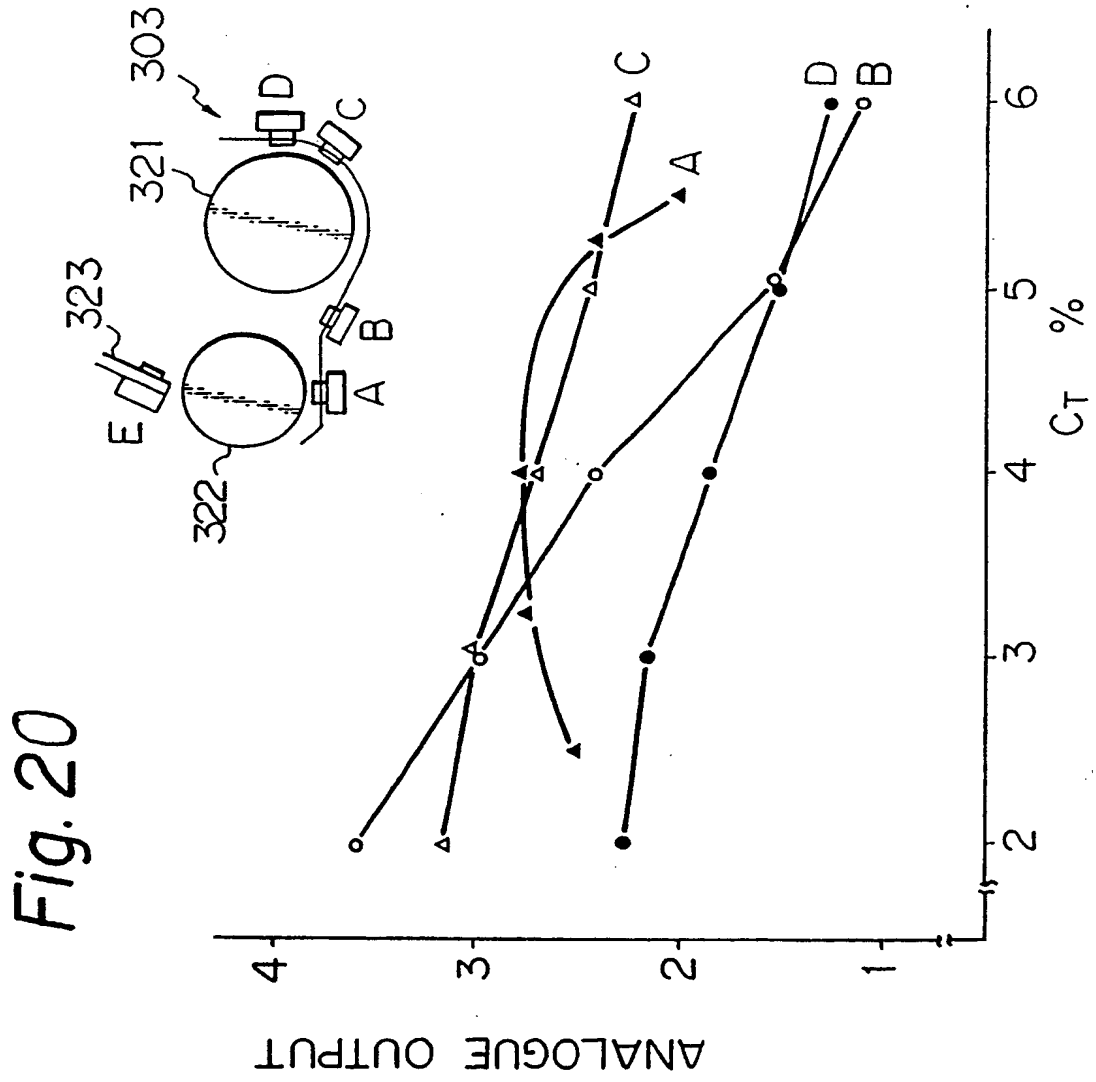


Fig. 20